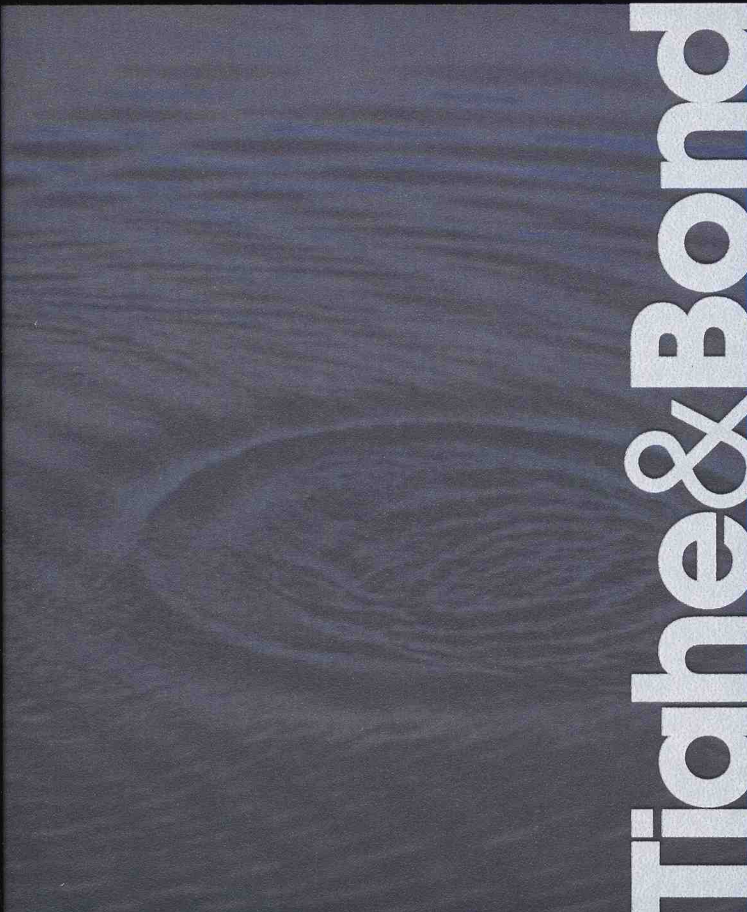


STORMWATER MANAGEMENT REPORT AND DRAFT REGULATIONS

Darien, Connecticut

Prepared for:

Town of Darien
Planning and Zoning Commission

October 24, 2008

Government • Real Estate • Education • Health Care • Industry

TOWN OF DARIEN

STORMWATER MANAGEMENT REPORT AND DRAFT REGULATIONS

October 24, 2008

TABLE OF CONTENTS

Contents

Appendices

Tables

Figures

1 INTRODUCTION

1.0 INTRODUCTION

Ongoing intense rainfall events in Town have made the importance of stormwater management a high priority. The Planning and Zoning Commission retained Tighe & Bond to provide guidance in adopting more comprehensive and definitive stormwater management regulations.

The Town has taken steps toward addressing various flooding issues. Adopting new stormwater management regulations in accordance with existing good practice is another positive step that will bring the Town closer to its goal of minimizing flooding from storm events. These regulations will be most effective when backed up with appropriate enforcement power based upon proper engineering design.

This report begins with an analysis of the existing regulations, identifying measures already in place, and other measures that could be implemented to improve the level of stormwater management on new development and redevelopment. This report also makes recommendations as to how the existing regulations can be strengthened, either by fine-tuning the existing requirements, or creating additional requirements. A brief overview of existing stormwater management requirements in other Connecticut municipalities is also included.

It is important to note that the recommendations for new requirements were made with a balanced approach to improve stormwater management, without making the requirements overly burdensome to property owners, or to overwhelm the Town's review agencies. The adoption of stormwater management regulations will serve the following purposes:

❶ Help protect adjacent and downstream property owners from adverse flooding impacts associated with increases in impervious surface coverage.

❷ Create consistent standards and review requirements that will serve as guidance for applicants, property owners, consultants and the Town.

2 EXISTING DRAINAGE REQUIREMENTS

2.0 EXISTING DRAINAGE REQUIRMENTS

Currently, the Town of Darien has set forth drainage requirements in the following documents:

- ❶ Zoning Regulations
- ❷ Subdivision Regulations
- ❸ Inland Wetlands and Watercourses Regulations
- ❹ 2003 Darien Stormwater Management Manual

This report concentrates on two documents under the jurisdiction of the Planning and Zoning Commission (P&Z): the Zoning Regulations and the Subdivision Regulations. It should be noted that the Regulations adopted by the Commission should be consistent with those of the Environmental Protection Commission (EPC), as well as the 2003 Darien Stormwater Management Manual. It is anticipated that the Stormwater Manual may require revision as a result of new Regulations adopted by both P&Z and EPC.

2.1 Zoning Regulations – Current Requirements

The Town of Darien Zoning Regulations, revised to November 11, 2007, contain several references to drainage and runoff, but few are specific as to design requirements. As part of this proposal, Tighe & Bond was asked to identify regulations which could be strengthened in light of the recent flooding in Town, and to foster more comprehensive stormwater management planning for future development.

Section 210 (Page II-5) of the Zoning Regulations defines “drainage” as:

> *The controlled removal of surface water or groundwater from land by drains, grading or other means which include runoff controls to minimize erosion, reduce suspended solids, and maximize groundwater recharge during and after construction or development.*

This definition broadly covers the main goals of stormwater management, speaking to controlling stormwater quantities, and improving stormwater quality through the primary means of total suspended solids removal and groundwater recharge.

The only specific mention of design criteria is made in Section 417c of the Regulations, which requires development projects shall incorporate drainage controls that eliminate the drainage impacts (i.e. not increase the peak rate of runoff) of the proposed development to adjacent properties and streets for the 2, 5, 10, 25 and 50 year storms. As written, this section is a requirement only of the Noroton Bay District Residential Zone (R-NBD) when special regulations for this neighborhood were adopted in 2003.

Other sections of the existing regulations require applicants to mitigate environmental impacts of their project, with storm drainage listed as one of the environmental factors. (*Reference: Sections 520b, 542b, 572b*). Additional sections simply state no improvement shall adversely affect adjoining properties with respect to drainage (*Reference: Section 548b*) or stipulate that stormwater runoff is to be controlled. (*Reference: Section 853b*)

Section 853 requires that applicants address storm water runoff for all land filling and regrading special permit applications submitted under Section 850 of the Zoning Regulations. It is generally believed that these are among the most stringent filling and regrading requirements amongst all of the municipalities in the State. They require an application for projects which require more than 20 cubic yards of excavation, fill or regrading. This results in the Planning and Zoning Commission reviewing 20 to 30 applications per year under this Regulation[1]. Thus, there are projects which are required to analyze stormwater now in Darien that may not be required to in another community. Such projects may or may not include any new impervious surface.

Section 1024 provides guidance on the content of site plans, with Section 1024.2f specifically requiring:

> *All engineering improvements shall be accompanied by appropriate data in accordance with good engineering practice such as quantity and velocity calculations, profiles, cross-sections, pipe sizes, flow lines, pipe slopes and lengths, invert and top of grate elevations.*

Section 1024.8 goes on to state that the Commission may require the applicant to provide an impact analysis of storm drainage. Section 1025.8 specifies:

> *That the design of stormwater drainage systems shall be such as to minimize soil erosion and maximize absorption of pollutants by the soil. Runoff from impervious areas shall be attenuated to reduce peak flow volume and sediment loads to pre-development levels.*

2.2 Zoning Regulations – General Analysis

The existing Zoning Regulations indicate the need for applicants to not adversely impact adjacent properties, but do not specify design criteria for various components of drainage system, or define what “adverse impacts” constitute. The concepts presented in the existing regulations can be improved and better defined by providing specific design objectives to be achieved, and the criteria for reaching those objectives, through the following means:

➊ Specify a design standard requiring consideration of downstream flooding.

➋ Promote infiltration practices where appropriate.

➌ Create a separate section of the regulations applicable to all zones, instead of interspersed drainage requirements throughout the regulations.

[1] Source: Planning and Zoning Department data 2002- present.

❹ Control outlet locations and require energy dissipation methods to reduce erosion.

❺ Emphasize stormwater quality as well as quantity (volume and rate of runoff).

❻ Clearly define documentation requirements for stormwater management submissions.

2.2.1 Downstream Flooding

There are five principal watersheds in the Town of Darien, including:

❶ Stony Brook

❷ Goodwives River

❸ Noroton River

❹ Five Mile River

❺ Tokeneke Brook

These watersheds are illustrated in **Figure 2.1.** Each watershed has unique characteristics and levels of development, and resultant flooding issues. We suggest that the Town take a watershed-based approach to stormwater management instead of a site approach, requiring the downstream flooding impact analysis, even where calculations have determined that the overall flow from a site will decrease. **Table 2.1** identifies the areas of these watersheds and the corresponding watercourse length.

TABLE 2.1. Watershed Characteristics

Watershed	Watercourse Length In Darien (mi)	Watershed Area (sq. mi.)	
		Total	In Darien
Stony Brook	3.80	4.1	3.8
Goodwives River	3.70	2.0	1.6
Noroton River	4.22	11.9	2.7
Five Mile River	1.69	12.5	0.9
Tokeneke Brook	3.20	1.2	1.2

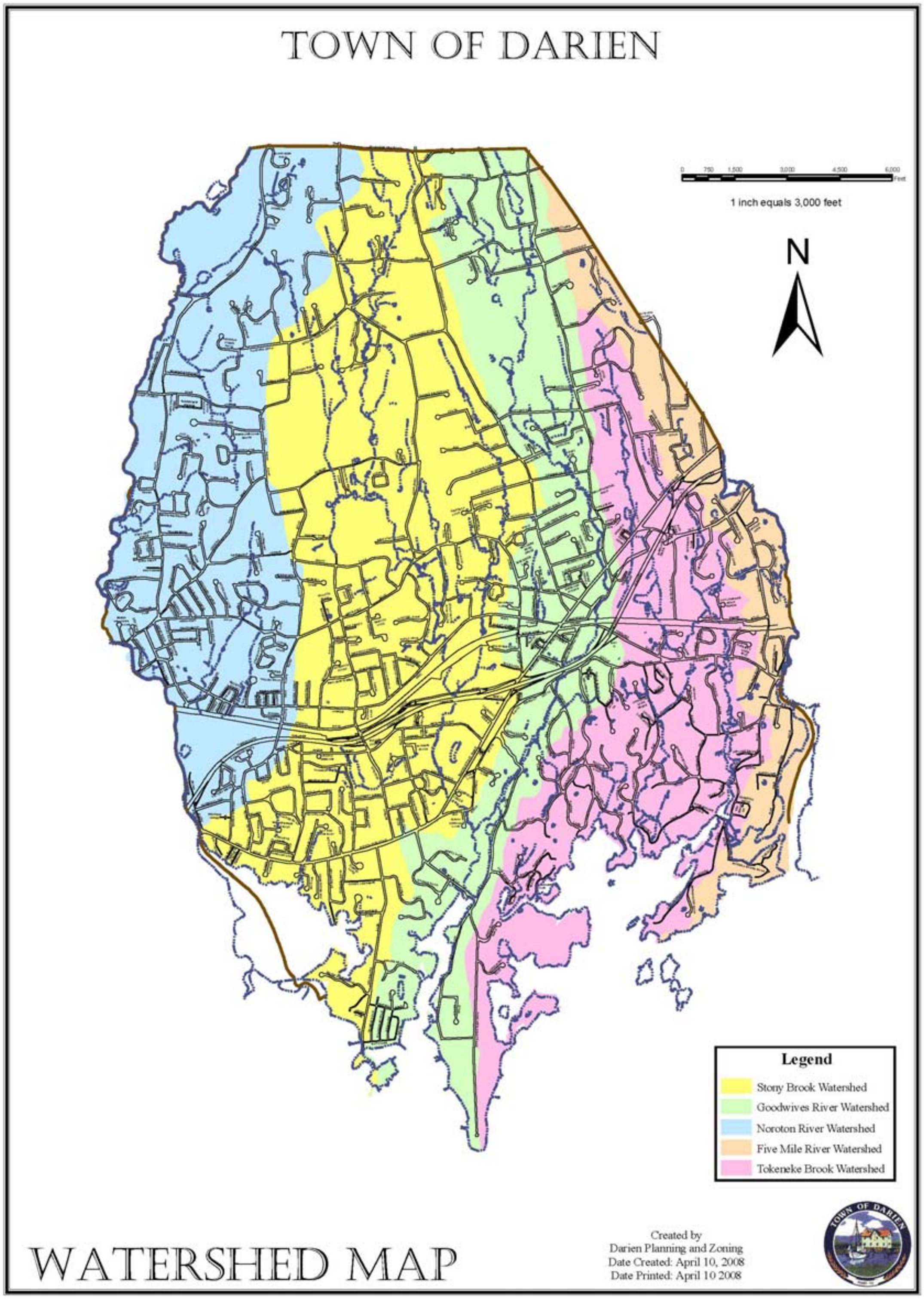


FIGURE 2.1. Darien Watershed Map (Illustrative Purposes Only)

In the past, accepted practice had been to simply compare the pre-development peak runoff rate of a site to that of the post-development conditions, to verify that the post-development peak runoff rate was no higher than the pre-development peak runoff rate. Although this is still generally valid for sites in the upper reaches of a watershed, this practice needs further evaluation for sites located in the middle and lower reaches of a watershed, especially where stormwater detention is involved to guard against simultaneous peaking.

TABLE 2.2. Simultaneous Peaking: Basic Concepts

Simultaneous Peaking: Basic Concepts

The concept of stormwater detention and simultaneous peaking is technical in nature, but fairly easy to understand with some graphical assistance.

First, it would be helpful to understand the concept of stormwater detention. **Stormwater detention** is the collection of stormwater onsite in either engineered ponds or underground chambers. The collected water is released in a controlled manner, usually through a small diameter pipe that has a limited capacity. The limited capacity of the pipe backs up the water level in the detention system.

Watersheds have a **time of concentration**, which is the time it takes for all the area of the watershed to contribute flow to the outlet of the watershed. Similarly, all sites have a time of concentration, which is the time it takes for the entire site to contribute flow to the outlet of the site. Generally, the more impervious surface a site has, the smaller the time of concentration.

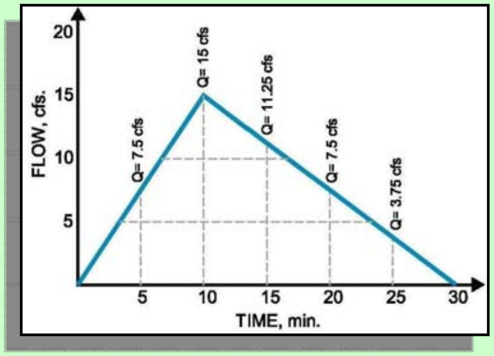
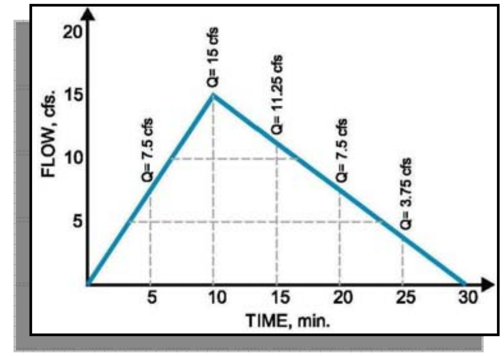
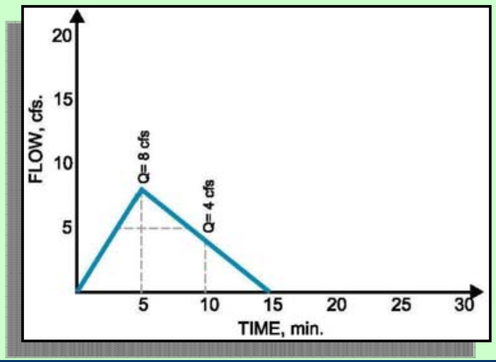
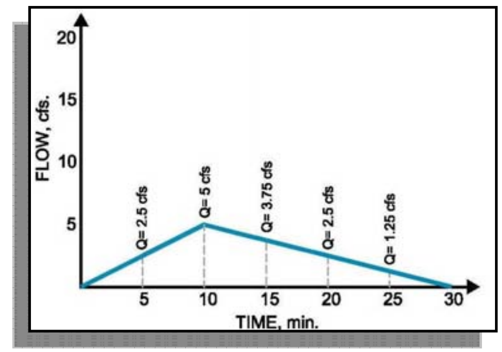
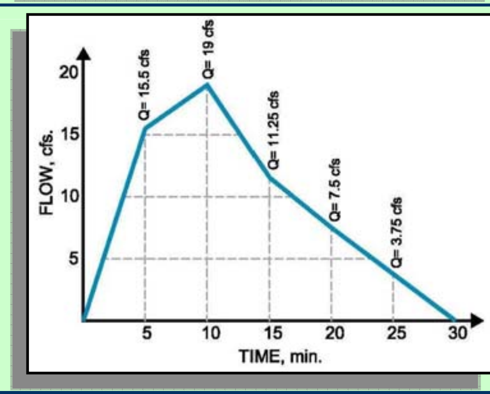
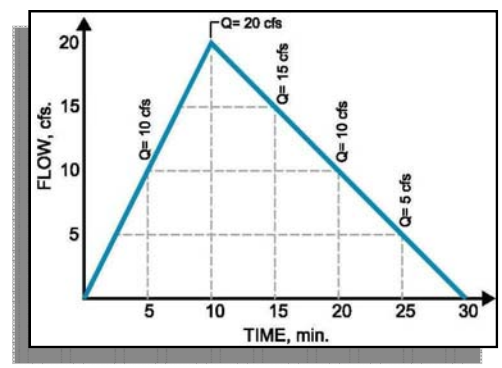
For the purposes of hydrology, the peak flow from the site is assumed to occur after the time of concentration, this is known as the **time to peak**. In some cases, the time to peak and time of concentration can be the same or close enough such that the difference is negligible. We shall assume that this is the case with this example. The time to peak can be illustrated graphically, by plotting the peak flow over time, called **hydrographs**. Hydrographs are combined to see the impact a site will have on a watershed.

Simultaneous peaking occurs when the time to peak of the watershed combines with the time to peak of the site. Since the time to peak is the moment in time of the peak flow, the flows at this simultaneous moment in time combine the peak flows of the watershed and the site.

Stormwater managers attempt to avoid simultaneous peaking. One way to manage this is to manage the times of concentration, either by minimizing the on-site time of concentration by releasing the stormwater into the watershed as fast as possible to "beat the peak", or by detaining it, releasing the stormwater at a rate slow enough such that the peak of the site occurs after the peak of the watershed.

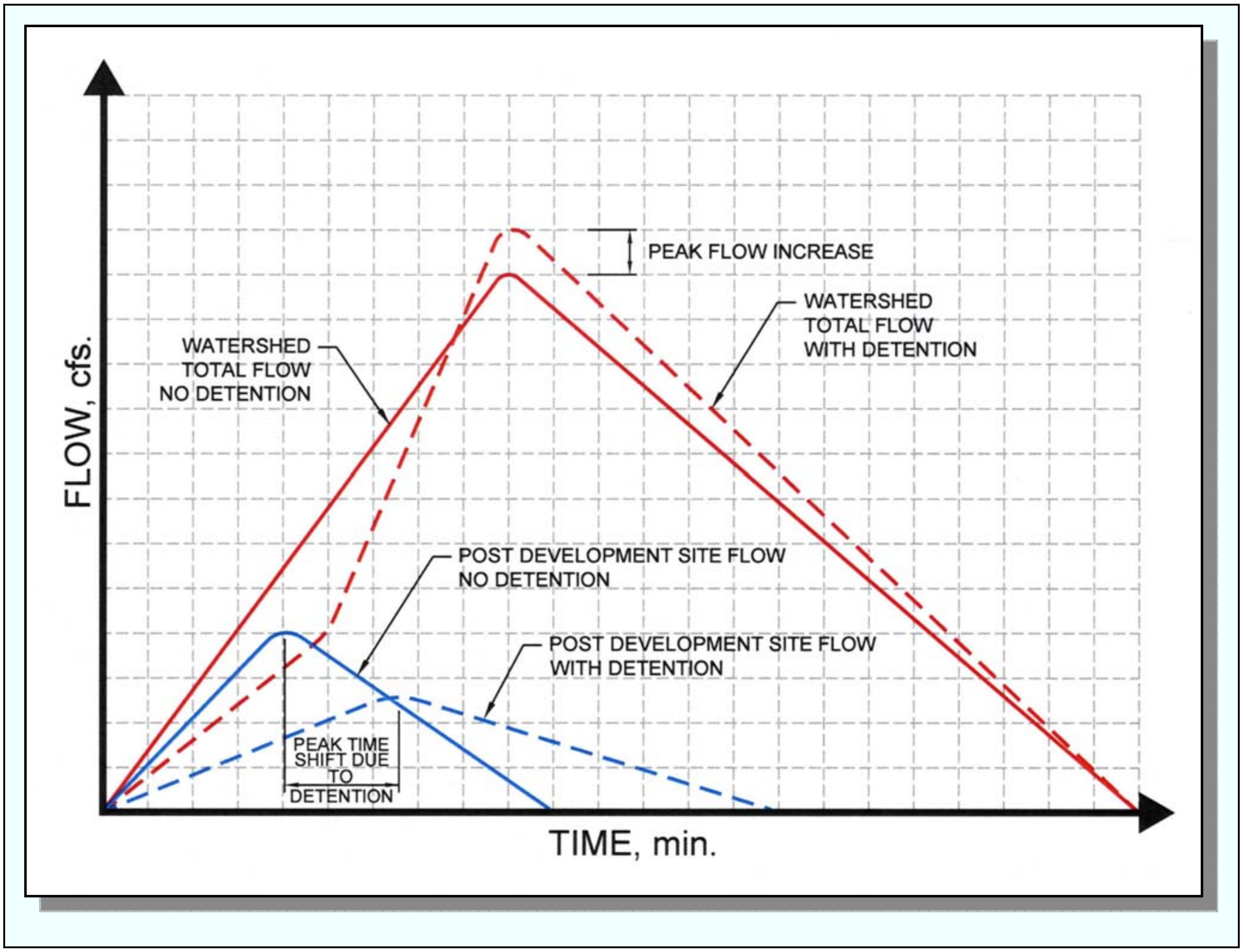
Please refer to **Figure 2.2** for an description of an illustrative example.

Figure 2.2. Illustrative Example of Simultaneous Peaking

Description	No Site Detention	Site Detention
Watershed Above the Site. The watershed above has a time of concentration of 10 minutes, and a peak flow of 15 cfs. Engineers often use the letter "Q" as a mathematical abbreviation for flow.		
Proposed Site. Without detention, the site has a peak flow of 8 cfs and a time of concentration of 5 minutes. If detention were applied to this site, the proposed system would reduce the peak flow of the site to 5 cfs, and extend the time of concentration to 10 minutes.		
Combining the Hydrographs In order to determine the impact to the watershed, the corresponding time points on the two hydrographs are added. Although detention reduces the peak flow from the site, it ends up INCREASING the peak flow in the overall watershed because the site time of concentration has shifted closer to that of the watershed.		

In these cases, it is possible that the flow from a site may be detained for a period long enough such that when the controlled flow from the site peaks, it does so simultaneously with the watershed above the site. In this situation, although the peak flow from the site is reduced by detention, the downstream flooding impacts are worsened by virtue of the combination of peak flows from the watershed and site peaking at the same time. This relationship is shown graphically in **Figure 2.3.**

FIGURE 2.3. Impact of Stormwater Detention on Simultaneous Peaking



Source: Center for Watershed Protection, Ellicott City, Maryland.

Therefore, it is important to structure the regulations such that the aim is not to solely reduce peak flow from the site, but to reduce downstream flooding impacts. One such solution would be to have the applicant compare the pre-development and post-development peak flows, but also evaluate the potential for downstream flooding impacts downstream to the point where the site watershed comprises ten percent or less of the overall watershed area.

This criteria is referred to as the "Ten Percent Rule". The ten percent criterion is a flexible and effective approach to verify that stormwater detention practices maintain pre-development peak flows throughout the system downstream. Based upon research by the Center for Watershed Protection in Ellicott City, Maryland, the ten-percent rule recognizes that a detention practice has a downstream zone of influence. Beyond this zone of influence, the structural control becomes relatively small and insignificant in comparison with the runoff from the total drainage area at that point. Based on studies and master planning results for a large number of sites, the limit of the zone of influence is considered to be the point where the drainage area controlled by the detention or storage facility comprises 10% of the total drainage area.

For example, if the structural control drains 10 acres, the zone of influence ends at the point where the total drainage area is 100 acres or greater.

2.2.2 Promotion of Infiltration Practices

The construction of impervious surfaces, such as pavement and roofs, effectively creates a barrier preventing rainfall from infiltrating into the soil. This rainfall becomes stormwater runoff. In order to replicate the infiltration of groundwater into the soil, it is a preferable stormwater management practice to direct runoff from rooftops and other impervious surfaces into the soil, where soil conditions are conducive to infiltration. This practice promotes the recharge of groundwater and reduces both the peak runoff rate and the peak volume of runoff.

Please note that not all soils are conducive to infiltration, and stormwater from "hot spot" areas (where there is a high probability of chemical contamination, such as gas stations) should not be infiltrated. Additionally, where infiltration practices are proposed, they should drain completely within 24 hours to ensure the full capacity of the infiltration treatment practice is available for the next storm. The design of these systems should be supported by both field test pit and infiltration testing data.

Infiltration is the only way to <u>reduce</u> runoff volumes, because it loses a portion of the stormwater runoff. Detention simply delays the discharge of runoff, but it releases the same volume over time. This concept is important for the subsequent discussion of requirements to control volume in Section 4.

2.2.3 Consolidation of Drainage Requirements

The existing drainage requirements are distributed throughout the existing Zoning Regulations, with references under the various zoning districts that have been established. Also, many activities, such as additions to single family residences or expanding driveways or terraces, are frequently exempt from drainage management requirements. In order to establish conformity in the approach applicants take toward drainage, it would be helpful if a single section of the Zoning Regulations was dedicated to stormwater management that covered all zoning districts, with some inherent flexibility built into the regulations to account for the location of the property within the watershed.

2.2.4 Outlet Design and Location

The current regulations make only a passing reference to outlet and outlet velocities. Outlet location and velocity play a critical role in downstream flooding effects. Outlets should be designed with the intent of maintaining existing drainage patterns without diverting runoff from one watershed to another. They should be carefully located to take advantage of existing natural channels, and should also be designed to dissipate energy from the concentrated discharge of stormwater. Energy dissipation is usually achieved by riprap aprons or preformed scour holes, and serve to reduce velocities, which in turn reduces erosion. The reduction of erosion will prevent the downstream transport of sediments which will eventually settle in ponds and on the channel bottom and, over time, reduce the available flood conveyance capacity of the channel, causing it to overflow its banks. Where natural channels or storm drainage systems are unavailable, point discharges should be discouraged in favor of level spreaders which distribute the flow across a wider area at a lower velocity.

Since outlets have erosion potential and maintenance concerns, new regulations should be considered to address their design.

2.2.5 Emphasize Stormwater Quality

Stormwater runoff carries pollutants that have been deposited on land and are later washed into rivers, streams, lakes, ponds, wetlands, marine waters, and groundwater. These pollutants include nutrients, suspended solids, organic carbon, bacteria, hydrocarbons and trace metals. In addition to exacerbating flooding, pollutant contaminated runoff significantly degrades water quality and aquatic habitat. The current regulations provide only passing reference to water quality, and should be strengthened to focus more upon the quality of stormwater, specifically, the Connecticut DEP's goal to remove 80% of total suspended solids.

Since Darien is a coastal community, it is subject to the requirements set forth in CGS §8-2 (b), CGS §8-23(a), and CGS §8-35(a), which require that zoning regulations be made with reasonable consideration of the restoration and protection of the ecosystem and habitat of Long Island Sound. Stormwater quality is one factor that influences the overall health of the Sound. The state's Coastal Area Management (CAM) regulations recognize the importance of stormwater quality, requiring the infiltration of the first inch of rainfall.

2.2.6 Define Documentation Requirements

The existing regulations give only a general overview of data required in support of the stormwater management aspects of an application. The requirements should be more clearly specified to allow the review process to move along more smoothly, but also to ensure that important aspects of stormwater management design that are sometimes overlooked would be considered by the applicant.

2.3 Subdivision Regulations – Current Requirements

Section I of the 1992 Subdivision Regulations prescribe specific drainage criteria, including the following:

❶ Zero increase in peak runoff from a site.

❷ Require backup computations for detention facilities.

❸ Establish a 50-year design storm for comparative hydrology.

- ❹ Account for the upstream drainage area.
- ❺ Evaluate downstream drainage impacts.

2.4 Subdivision Regulations – Analysis

The Subdivision Regulations currently provide more specifics than the Zoning Regulations with respect to stormwater quantity, but do not specify how far down the downstream impacts are to be studied. In addition, the Subdivision Regulations do not provide any requirements for stormwater quality.

Article III, Section A of the Subdivision Regulations notes the various drainage information that must be submitted as part of an application. Article IV, Section I lists the requirements noted above.

2.5 Inland Wetlands and Watercourses Regulations – Current Requirements

The Town's Inland Wetlands and Watercourses Regulations do not set forth any particular standard for drainage design. Section 7.5.b of these regulations simply require "Engineering reports and analyses to fully describe the proposed project, any filling, excavation, drainage or hydraulic modification to watercourses." Section 7.5.g further requires mitigation of flooding, degradation of water quality, erosion and sedimentation, and obstruction of drainage. Section 7.5.h requires applicants to develop a post-activity monitoring plan to ensure that drainage structures are functioning in accordance with "predicted behavior".

In its criteria for decision, Section 10.2 states that the Commission shall consider the proposed action's impact upon flooding, sediment control and drainage.

2.6 Inland Wetlands and Watercourses Regulations – Analysis

Although there are no specific design requirements in the Inland Wetland Regulations, the Environmental Protection Commission does request applicants meet certain design criteria depending upon the project proposed. We suggest that any proposed standards adopted by the Planning and Zoning Commission be used by the Environmental Protection Commission and referenced specifically in the Inland Wetlands and Watercourses Regulations, so that there are consistent standards "across the board", providing clarity for applicants, and ensuring that all projects are designed to the same criteria without having a drainage plan having to be reviewed multiple times under different standards and/or criteria..

3 STORMWATER MANAGEMENT IN OTHER CONNECTICUT MUNICIPALITIES

3.0 STORMWATER MANAGEMENT IN OTHER CONNECTICUT MUNICIPALITIES

Communities throughout the region have stormwater management regulations, with requirements varying town to town. In general, Darien's existing regulations with respect to design standards tend toward the more stringent end of the spectrum. Currently, a 50-year storm is the design basis for hydrologic comparisons within Town. Many Fairfield County municipalities, including New Canaan, Westport and Wilton require an analysis up to the 25-year storm. Other communities using a 50-year design standard include Bridgeport and Danbury.

In its 2003 Stormwater Management Manual, the Town of Darien has also identified specific guidelines for stormwater quality, documentation requirements, and computational methods. These guidelines exceed those available in other area municipalities. Although not officially adopted by the Town, the Town's land use agencies have been using the 2003 Stormwater Management Manual as a basis for project reviews.

Darien also has more stringent land filling, excavating and regrading requirements with respect to other Fairfield County municipalities, requiring Planning and Zoning Commission review of many applications under these regulations annually. Land filling and grading activities can have a significant impact upon drainage patterns. Last year, the Commission received 28 of these applications. In many municipalities these would typically be handled administratively if they are even reviewed at all. Newtown once had a requirement that any land grading on a lot be limited to no more than 200 cubic yards of cut or fill import/export. This requirement was recently rescinded because it resulted in more land disturbance as a larger area of land was disturbed in order to cut or fill the area within the volumetric requirements.

Creating new stormwater regulations that are overly stringent has the potential to overwhelm the Town review agencies, or have unintended consequences as property owners try to avoid having to appear before local boards or commissions.

Other communities have begun to define thresholds at which a full drainage analysis is required. Currently, Darien has no specified threshold at which a drainage analysis is required. New Canaan recently instituted a requirement that any increase of impervious surface 1,000 square feet and greater would require a drainage analysis.

4 STORMWATER MANAGEMENT CONSIDERATIONS

4.0 STORMWATER MANAGEMENT CONSIDERATIONS

During Tighe & Bond's kick-off meeting with Planning and Zoning, Public Works, and Environmental Protection staff, various items of concern and study were brought to our attention with respect for new requirements, compliance thresholds, and enforcement. This section discusses some of those concerns.

4.1 Town of Darien (Municipal) Projects

In some communities, municipal projects are exempt from their own stormwater management regulations. However, municipal projects do not have any less impact upon drainage conditions than private projects of similar size and scope. Certainly from a public relations point of view, Town projects should generally set examples for good stormwater management practice. However, in cases of emergency, as determined by the Director of Public Works, to protect the health, safety, and general welfare of the public, it may be necessary to undertake a project that does not conform to all aspects of the regulations. In these cases, the project shall be implemented to the extent necessary to satisfy the emergency condition, and then be followed up with enhancements and retrofits to conform to the stormwater management regulations.

► **Recommendation:** Exempting Town projects from stormwater regulations, except in the case of emergency, is not warranted.

4.2 Basis of Existing Conditions Analysis

Stormwater hydrology is comparative, typically involving a comparison of post-development conditions to pre-development conditions. Some area communities have been disallowing credit for existing impervious coverage on a site, instead requiring the existing conditions to be modeled in their undeveloped condition.

The premise behind this requirement is to require post-development flows to be reduced to that of those that would be generated if the site were totally undeveloped, greatly reducing peak runoff from the site and into downstream systems. This practice, which from an engineering perspective is very conservative, results in a situation where the stormwater management system for the development site is designed to release a lower rate of peak runoff than if actual existing conditions at the site were used for a basis of comparison, generally providing an additional factor of safety in the analysis.

The Joint Stormwater Subcommittee endorses this approach for "teardowns" of residential and commercial structures. The drawback of this approach is that it does not accurately reflect true existing conditions. In situations where there is detention on an existing site, discounting existing development could actually worsen the impact of the development because of the relationship of the time of concentration of the site with respect to the watershed and/or adjacent developments.

An example of this would be where an undeveloped site has been developed with a detention system. The detention system attenuates the peak flow from the development site to a rate less than that of the peak flow from the undeveloped condition. If this site were to be redeveloped, the comparative hydrology would use the higher peak flow from the undeveloped condition as a basis of the existing conditions, instead of the lower peak flows from the developed conditions, which other systems in the watershed could be designed around. This is especially important if applicants will be encouraged to over-detain storms as discussed in Section 4.14.

TABLE 4.1. Undeveloped Conditions and Detention

Example
A 5-acre undeveloped site has a peak flow of 8.5 cfs. The site is later developed, and without detention, the site will generate a peak flow of 23.4 cfs. As a result, the site engineer designs a detention pond that is enlarged to over detain the storm, which attenuates the peak flow from the site to 3.7 cfs. If redevelopment efforts would require using undeveloped conditions as the basis of the existing comparison, the redevelopment would be able to have a peak flow rate of up to 8.5 cfs. Since the true existing condition is a peak flow rate of only 3.7 cfs, the redevelopment would have a HIGHER peak flow rate.

Another approach that other jurisdictions have used is to require the flow from a site be reduced to a certain percentage of the actual pre-development flow rates. This can only be achieved by modifying land use, lengthening times of concentration, or by detention. Other than modifying the proposed land use, this practice leads to more stormwater management practices to maintain, and the use of detention to achieve this reduction may not be feasible in middle and lower reaches of a watershed.

We understand the desire to require undeveloped conditions as the basis of the existing conditions analysis because it generally is more conservative. However, the noted exception can be where detention is involved, in which case, using undeveloped conditions as the existing conditions could be counter-productive. Therefore, where detention is involved, true existing conditions should be used.

► **Recommendation:** Where residential dwellings or commercial buildings (accessory structures excepted) are proposed to be razed and replaced, the basis of analysis for hydrologic comparisons shall be pre-existing conditions with a land use as undeveloped meadow, unless there is an existing stormwater detention system on the site. Where the existing site contains stormwater detention, the existing conditions at the time of application shall be used.

4.3 Design Frequency Requirements

The Zoning Regulations, aside from the requirements of the Noroton Bay District Residential Zone (R-NBD) (Section 417c), do not prescribe any sort of storm design frequency. The

1992 Subdivision Regulations require no increase in peak flow from a proposed development for the 2, 5, 10, 25 and 50 year storms. Even when components of the drainage system are designed for a 25 or 50 year storm, there will be rainstorm events like those experienced within the past few years, that will result in the systems being temporarily inadequate and storm water will "flood" into areas that are not normally inundated.

Although storms are termed by a specific return frequency measured in years, that terminology is often misleading. A 100-year storm doesn't mean that there is only one storm of a 100-year magnitude in the time frame of 100 years. It is possible to have two 100-year storms in the same year. Design storms are defined on a probabilistic basis. For the so-called "100-year storm", there is a 1% chance of it happening in any given year. Likewise, the 25-year storm has a 4% chance of occurring in any given year. However, since the industry standard is to describe return frequency in years, we will follow the accepted convention.

Design storms. For hydrologic analysis, most of the area municipalities require a 25-year analysis for the design of the on-site piped drainage system. Darien's requirements are already more stringent, requiring no increase in peak runoff from the 2, 5, 10, 25 and 50 year storms.

Table 4.2 below summarizes the rainfall depths for storms of given duration and intensity.

TABLE 4.2. Rainfall Duration-Frequency Relationships

Duration	Return Frequency (Years)					
	2	5	10	25	50	100
5 Min.	0.36 in	0.45 in	0.51 in	0.60 in	0.67 in	0.73 in
15 Min.	0.72 in	0.89 in	1.02 in	1.20 in	1.34 in	1.48 in
60 Min.	1.30 in	1.70 in	2.00 in	2.30 in	2.57 in	2.80 in
2 Hr.	1.60 in	2.15 in	2.50 in	2.85 in	3.25 in	3.60 in
3 Hr.	1.75 in	2.40 in	2.75 in	3.25 in	3.55 in	4.00 in
6 Hr.	2.35 in	2.95 in	3.45 in	4.00 in	4.55 in	5.00 in
12 Hr.	2.75 in	3.55 in	4.00 in	4.85 in	5.35 in	6.00 in
24 Hr.	3.25 in	4.20 in	4.95 in	5.75 in	6.35 in	7.00 in

Source: Connecticut Department of Transportation, Drainage Manual 2000.

It should be noted that recent studies by the University of Connecticut have shown that the rainfall totals have been increasing steadily over the years. The rainfall frequency-duration relationships that are set forth by the Connecticut DOT Drainage Manual were developed in the 1960s using approximately 30-40 years of climatological data. The study suggests that more intense storm events are happening on an increasingly frequent basis. It is also important to note that the state agencies that typically set technical guidance for stormwater management standards, DEP and DOT, have yet to officially adopt the new rainfall totals.

There have been suggestions of adding a 100-year storm to the design requirements as is done in some other municipalities. The 100-year storm can be analyzed with minimal effort using most of the electronic modeling available today, and would not generate additional materials to review for an application. The 100-year storm requirement would result in larger stormwater management facilities, increasing capital costs for both private and municipal projects, but would afford an additional level of management.

However, designing and constructing for a 100-year design is not always practical or logical. For example, although stormwater conveyance systems can be sized for the 100-year storm, in reality, the capacity would be limited to the ability of the catch basin to pass intercepted stormwater into the conveyance system. Since the interception capacity of catch basins is limited, more and larger catch basins would be required to adequately collect the 100-year storm, but this would result in significantly more catch basins to maintain, and more opportunities for sediment to wash off into the storm drainage system.

100-year storm designs are more practical for detention facilities, because when these facilities overtop, the potential for damage is greater, including damage to the facility itself. All detention ponds and other detention facilities open to the atmosphere should be designed with one foot of freeboard to provide an additional factor of safety.

Therefore, many municipalities, and the State, have differing design frequency requirements depending on the facility that is being designed. The 2003 Darien Stormwater Management Manual prescribes design storm frequencies for various facilities, repeated here in **Table 4.3.**

TABLE 4.3. Design Storm Frequencies for Various Stormwater Management Facilities

Facility	Design Frequency
Storm Drains	
Local Streets	25
Parking Lots	25
Collectors and Arterial Streets	25
Collector and Arterial Streets at Sags[1]	50
Drainage Channels and Ditches	25
Culverts[2]	
Upstream watershed area < 1 square mile	50
Upstream watershed area $\geq$ 1 square mile	100
Bridges	100
Detention Facilities	100

[1] Sags are defined as the lowest point in a vertical curve where water can only be removed through a storm system. The inlet at the sag shall be designed to accommodate a 50-year storm, while the remainder of the storm drainage system can be designed to accommodate the 25-year storm.

[2] Crossings of watercourses will require design for the 100-year storm, regardless of the size of the upstream watershed area. For those critical activities as defined in Section 25-68b through 25-68h, CGS, the design storm frequency shall be 500 years.

Source: 2003 Darien Stormwater Management Manual

In any case, stormwater facilities shall be designed such that downstream flooding conditions are not adversely impacted.

In order to make comparisons meaningful between projects, all projects throughout Town should utilize uniform rainfall data. Values for the rainfall data can vary depending upon the source of that data. The 2000 Connecticut Department of Transportation has data for the State of Connecticut, Section 6.B-1. The Darien Stormwater Management Manual also has a rainfall-intensity-duration curve, reflecting the higher rainfall totals in Fairfield County, whereas the State manual represents an average of the entire State.

► **Recommendation:** A one-size-fits-all approach to all drainage facilities is not practical given the various functions individual elements serve. Instead, it is more practical to prescribe specific design frequencies as shown in Table 2, because the purpose and overall capacity varies from facility to facility.

4.4 Hydrologic Methods

Numerous methods are available for the analysis of watersheds, depending on the area and level of development to be modeled. These are outlined in Chapter 4 of the Town Stormwater Management Manual.

► **Recommendation:** No one particular model should be required because of the site-specific nature of the modeling. Instead of a one-size fits all approach, a listing of accepted models should be referenced, with the modeler having the flexibility to choose the most appropriate model. The same modeling method should be used for existing and proposed conditions for the purposes of comparison.

4.5 Stormwater Detention

Drywells and infiltrators are used to reduce the amount or runoff water leaving the site by collecting the rainwater from impervious surfaces and redirecting the water into the ground where it can be absorbed. Storm water detention systems hold back or delay the release of the rainwater. Detention is a common stormwater treatment practice used to attenuate peak flow from a developed site. The concept of detention is to hold stormwater on-site, typically in a pond or underground chambers, and slowly release it at a controlled rate over time so that the post-development flow rate does not exceed that of the existing conditions.

Stormwater detention ponds, when designed appropriately, are effective at removing urban pollutants (such as road sand, oil drippings, leaves, trash and debris, etc) from stormwater. Treatment is primarily achieved by the sedimentation process where suspended particles and pollutants settle to the bottom of the pond. In some instances, trace metals and other soluble pollutants can bind to the sediment particles and settle to the bottom. Larger ponds can also provide aquatic habitat.

The use of detention with respect to the watershed must be carefully considered, because detention could exacerbate flooding downstream of the site if the on-site water is detained long enough such that the timing of the peak flow from the site coincides with the peak time of the overall watershed it discharges into. The "Ten Percent Rule", as discussed in Section 2.2.1, is one tool to verify that on-site detention won't have a detrimental impact to downstream flooding conditions.

► **Recommendation:** Any design involving detention must check for downstream impacts by doing a watershed study prescribed by the "Ten Percent Rule".

4.6 Low Impact Design

Low impact design is the design or selection of materials that reduce imperviousness and improve groundwater infiltration. Low impact design methods include alternative paving materials, such as permeable pavers, narrower driveways, narrower street widths, smaller standard parking spaces or alternative cul-de-sac turnaround configurations. Reducing the width of a street will result in less impervious surface, but must be weighed against the need for on-street parking and vehicular safety. Similarly, alternative cul-de-sac designs should be evaluated for emergency vehicle maneuverability.

Other low-impact design elements include disconnection of roof top runoff, disconnection of non-rooftop runoff, elimination of curbs in favor of roadside swales, and the use of rain gardens.

Darien has a building coverage maximum in all zoning districts of 20%. In some zones there is also a Developed Site Area maximum. These regulations limit the amount of building and/or impervious surface on a lot. In general, these limits are stricter than many local communities.

Some jurisdictions throughout the country allow credits for the use of more pervious hardscape materials such as patios, decks and gravel and stone driveways. These credits can take various forms, such as allowing additional coverage, or more commonly, allowing reduced runoff coefficients for the permeable paving materials.

Unit pavers are impermeable blocks made of brick, stone or concrete and set on a prepared sand base. The joints between the blocks are filled with stone dust, which limits the blocks from rocking in place and allows water to infiltrate downward. In order to have effective infiltration, the unit pavers must be constructed over a base course of crushed stone that doubles as a reservoir for the stormwater. Additionally, the subsurface soil should have an infiltration rate equal or faster than 0.3 inches per hour.

One of the concerns expressed at the kick-off meeting was that sometimes the subsoils become overly compact, limiting infiltration, or replaced with impervious surface. Allowing credits to be taken for low-impact design provides an incentive to use those practices. Low-impact design practices tend to be more expensive than traditional approaches, so allowing the credits would serve as an incentive that may possibly offset the additional cost.

► **Recommendation:** There are stormwater quantity and quality benefits to incorporating low-impact design. However, there are also Planning issues beyond the scope of this report which also must be considered by the Commission. We recommend that the Planning and Zoning Commission study the merits and feasibility of Low Impact Design in the future.

4.7 Outlet Locations

Where possible, outlets should be located such that they discharge into existing drainage facilities or channels, providing that the receiving location has sufficient capacity and the increased volume will not cause erosion.

Where no existing channel exists, stormwater shall be discharged across a level spreader or similar stormwater treatment practice such that concentrated discharges of stormwater are avoided.

Prior to discharge, all stormwater outlets to grade shall have a method for energy dissipation, such as riprap aprons or preformed scour holes, designed in accordance with the State of Connecticut DOT Drainage Manual. Energy dissipation reduces stormwater velocities, preventing downstream erosion and flooding by minimizing sedimentation of eroded material which would otherwise reduce channel conveyance capacity. Level spreaders are an acceptable method of velocity dissipation provided that it can be documented that discharge velocities are less than the erosive velocities of the existing soil type.

Outlets should be located such that all energy dissipation structures are within the property boundary of the proposed development, so that they can be maintained, or drainage rights will need to be obtained. In the case of level spreaders, they shall be located a minimum of 10 feet inside the property line to allow the water to be spread out and create sheet flow rather than concentrated flow. Also the 10-foot setback area for the level spreader can be employed for continuous maintenance access around the level spreader.

► **Recommendation:** A new Zoning Regulation addressing outlet locations is required to better define outlet location preferences, and more importantly, to stipulate energy dissipation requirements such that outlet velocities can be reduced, preventing erosion and subsequent downstream sediment deposition.

4.8 Infiltration Practices

Infiltration should be required where practical as it helps attenuate peak flow rates, volumes, and promotes recharge of groundwater otherwise cut off by installation of impervious surfaces. The 2003 Darien Stormwater Management Manual requires the following runoff depths over the site impervious area to be recharged as shown in **Table 4.4**, based upon the United States Natural Resources Conservation Service (NRCS, formerly SCS) Soil Survey of Fairfield County, Connecticut. Group A soils tend to be most pervious, consisting of gravel and sand, while Group D soils are the least pervious, having the highest clay content.

TABLE 4.4. Groundwater Recharge Depth

Hydrologic Group	Depth, Inches
A	0.40
B	0.25
C	0.10
D	No recharge requirement

Source: 2003 Darien Stormwater Management Manual

Infiltration practices should be preceded by a pretreatment practice to prevent clogging of the system which would prevent the soil from allowing infiltration. An exception to the pretreatment practice would be for rooftop runoff from non-metal roofs, because stormwater runoff from roofs does not have the concentration of pollutants found on impervious ground surfaces. Provisions should be made in all infiltration practices for maintenance and inspection of the practice, as well as high-level overflows as an additional safeguard in the event the system becomes clogged.

Prior to submission all infiltration practices should be supported by soil testing data that estimates the permeability rate of the soil and the location of the seasonal high groundwater surface relative to the bottom of the infiltration practice to verify that groundwater will not flow into the proposed facility, reducing the available storage inside. All infiltration practices should be designed to provide a complete drawdown within 24 hours to ensure that the full volume of the system is available for the next storm.

During the kick-off meeting with the Town, one of the suggestions mentioned was to require a factor of safety on the testing rate such that the design rate would be lower than the field tested rate. This would have the end result of the designed systems being larger, but may reduce the requirement for additional maintenance activity on the part of the property owner. Any factor of safety should be carefully chosen to avoid making these systems unduly large. One suggestion would be to have the field permeability rates rounded up to the next 5-minute interval. For example, if a field test reveals a permeability of 1 inch in 21 minutes, the design rate should be 1 inch in 25 minutes. The maximum rate allowed for design should be 1 inch in 5 minutes. It is difficult to establish specific rates less than this by field testing of the ability to absorb water.

Where infiltrators and drywells are used, they shall be located a minimum of 10 feet from the property line and 15 feet from a building on adjoining property. The 10 feet will provide access around the structure for maintenance purposes, while the building setback is meant to minimize the potential of drywell or other structure infiltration into adjacent structures. These separations are based upon the minimum separation distances prescribed by the Connecticut Department of Health for subsurface sewage disposal systems.

During construction, heavy construction equipment should be prohibited from travelling over the area designed for use as infiltration, except for the purpose of the direct construction of the system. Photos shall be taken of the system to document its installation is in accordance with the approved plans. All plans shall have a note to this effect.

► **Recommendation:** A new regulation incorporating the minimum depth of infiltration based upon soil type should be included, along with requirements for soil testing, pretreatment, limitations on stormwater runoff sources that can be infiltrated, heavy equipment prohibitions, as-built verifications standards, maintenance requirements, system location and design rate. This regulation would provide consistency in infiltration system design and impress the importance of supporting soil testing data.

4.9 Certification Requirements

Section 321.3 of the Darien Zoning Regulations (Page III-4) stipulates that no Certificate of Zoning Compliance shall be issued for the occupancy of any building shown on any subdivision or site plan approved by the Planning and Zoning Commission until the Zoning Enforcement Officer (ZEO) has determined that all utilities, drainage and street improvements required on the plans have been installed. There is currently no certification regulation from the owner or a designated owner's agent, such as an Engineer. Land use boards have become more proactive, and often require drainage as-built certification as a condition of approval.

Danbury, Wilton, and Stamford are a few area municipalities that require an as-built certification of drainage installations. The value of these certifications is that it provides a mechanism by which the certifying professional has an opportunity to inspect the installation of the proposed stormwater management system and then to verify that it has been installed in general conformance with the approved design plan.

Where plans are prepared by a professional engineer, the engineer signing and sealing the plans shall provide a certification letter stating that the system was installed in substantial conformance with the approved drawings. The certification letter shall be accompanied by a copy of the as-built drawing signed and sealed by a licensed surveyor in the State of Connecticut.

Where drainage plans have not been prepared by a professional engineer, a signed statement by the owner shall be submitted stating that the system was installed in substantial conformance with the approved drawings. The certification letter shall be accompanied by a copy of the as-built drawing signed and sealed by a licensed surveyor in the State of Connecticut.

► **Recommendation:** A new regulation requiring as-builts and certification of drainage for <u>all</u> site improvement and/or construction projects would provide an additional opportunity to verify that was shown on the approved plans was actually installed. This is already a requirement in other Fairfield County municipalities, including Danbury, Wilton, and Stamford.

4.10 Maintenance Agreements

In order to be most effective, stormwater treatment practices require regular maintenance. Maintenance requirements and schedules are helpful tools for private property owners, and provide the proper guidance to assist them in maintaining the maximum efficiency of their stormwater controls. Many area municipalities require submission of a maintenance plan as part of the approval process.

In general, the system will need routine maintenance such as minor cleaning once or twice a year. It should be inspected at least every two years by a professional. An easy way to track the inspections would be to require that sites and buildings with an even street number must be inspected during the even calendar years, and the sites and buildings with an odd street number must be inspected during the odd calendar years.

In some instances, maintenance agreements may not be appropriate, such as a simple roof leader draining to grade. Where more complex facilities exist, such as stormwater outfalls, catch basins or infiltration systems, the maintenance requirements and schedules shall be entered on the Darien Land Records identifying the required maintenance and frequency of maintenance.

► **Recommendation:** A new Zoning Regulation requiring the submission of maintenance requirements and schedules, and recordation of the maintenance requirements will provide a mechanism to transfer the maintenance requirements for private systems in perpetuity.

4.11 Stormwater Volume Requirements

During the kick-off meeting with Town staff, one of the concerns that was brought up was volume control. Impervious surfaces increase total volume, because rainfall that would have been absorbed into the soil cannot infiltrate the impervious surface, and as a result runs off the site as stormwater runoff. The only way to control runoff volume is infiltrating it into the soil, but in many instances, the ability of the soil to infiltrate runoff is limited by its composition. In some instances, it will be impossible to infiltrate stormwater.

Total volume is a less important metric for flooding evaluation than peak flow rates. Peak flow rates are measured in units of volume over time, essentially giving the volume of stormwater passing through a point at any one given time. Typically, the measurement is in cubic feet of water per second (cfs). Stormwater detention discharges the same total volume as the same site without detention, however, the peak flow rate is less because the volume is slowly metered out over time such that there is a reduced volume at any one given time.

Development generally increases imperviousness, which also increases volumes. Since the volume at any one given time is more critical in determining downstream flooding impact, there is little value in requiring reductions in total volumes.

It should also be noted that as part of the United States Green Building Council's LEED Certification Program, one of the Sustainable Site credits requires a 25 percent reduction in the two-year storm volume. As the desire to construct "Green" buildings increases, along with recent state mandates for green design of public buildings, there will likely be attempts to reduce stormwater volumes from a project in order to meet these credits.

► **Recommendation:** No requirement should be made for volume reduction aside from the infiltration requirements previously discussed.

4.12 Drainage Analysis Thresholds

Imperviousness has a direct relationship to the volume and rate of runoff from a site. Area communities are requiring projects adding over a certain amount of impervious surface to prepare drainage analyses. New Canaan requires applications adding 1,000 square feet or more of impervious surface to prepare and implement drainage plans.

A specific threshold would be helpful in establishing where a full drainage analysis would be required while not overwhelming review agencies with volumes of drainage studies to review, and drainage plans to enforce, and also not to make small, routine projects overly burdensome to homeowners. We believe that 1,000 square feet is a reasonable threshold.

It should be noted that any application requiring action by a Land Use Board (Planning & Zoning Commission, Zoning Board of Appeals, Environmental Protection Commission) will require a drainage analysis.

In all cases, where an existing residential dwelling structure will be torn down and replaced with a new residential dwelling structure, a drainage analysis should be required.

The definition of what to include as impervious surface was also discussed with staff. Impervious surface, for the purposes of these regulations, would include structures and equipment pads, as well as patios, parking areas and driveways, regardless of their surfacing materials. We recommend some exceptions to the definition of impervious surfaces:

➊ Pools should not be included in the impervious surface definition, because they typically have a certain degree of freeboard before they begin to contribute runoff.

➋ Resurfacing of existing driveways, including gravel driveways, and patios should not count toward the coverage threshold because these surfaces, by their nature already act as impervious.

➌ Golf cart paths do not count as driveways because of their light-duty nature. Since golf courses frequently move their golf cart paths, it is desired to minimize the additional review effort on behalf of the Town, since most of the relocations are minor. Major relocations are typically done as part of larger projects that would trigger a drainage review under the grading and land filling regulations.

Patios are included in the definition of impervious surface, however, we do not anticipate that the requirement would be overly burdensome on property owners because the threshold is very large in comparison with most patio projects. Typically, projects involving 1,000 square feet or more of patio surface are part of a larger project that would trip other requirements for drainage analysis.

Please refer to **Appendix A** for examples of applying this threshold.

► **Current Recommendation:** Where projects propose the addition of 1,000 square feet or more impervious surface, not including pools or driveways, the applicant is to submit a full drainage analysis documenting no adverse flooding impacts. Additionally, a time constraint or running total should be incorporated into this regulation to prevent people from skirting the requirements by incrementally adding impervious area beneath the threshold to skirt the threshold review.

We also recommend that impervious surface be defined as structures, equipment pads, as well as patios, driveways and parking areas regardless of surfacing material. Exceptions from this definition for pools, resurfacing of existing driveways and patios, and golf cart paths are also recommended.

Finally, we also recommend that any application requiring a review by any local land use board require a drainage analysis.

4.13 Emergency Situations

The Joint Stormwater Regulations Subcommittee recommended an option that would allow for a waiver of the requirements for emergency conditions. We agree with this recommendation, especially where the health, safety, and welfare of the public is potentially at risk. In certain situations, emergencies may dictate certain work be performed to alleviate the emergency situation and protect the health, safety, and welfare of the public.

In these cases, a drainage analysis is not required before the implementation of an action, but should be revisited after implementation as soon as practicable for conformance with the stormwater management regulations.

► **Recommendation:** In the event of an emergency, an action may be implemented to the extent necessary to satisfy the emergency condition, and then be followed up with enhancements and retrofits to conform to the stormwater management regulations as soon as practicable.

4.14 Exceeding Minimum Standards

The Joint Stormwater Regulations Subcommittee recommended language encouraging property owners to go above and beyond the minimums stated in the standards in an effort to have a positive impact in flood prone areas. In general, the opportunities for additional positive impact are limited for residential properties, and are best available on commercial properties, which tend to be larger, and in more heavily developed areas of Town. Actions that would go above and beyond the minimum include, but are not limited to, over-detaining storms to further reduce post-development conditions runoff in comparison with existing conditions, reducing parking to the minimum required by zoning. We concur with their recommendation of language encouraging additional effort, provided that the impacts of this additional effort are analyzed such that they don't have an adverse affect on flooding. In the case of over-detaining, it is possible to detain a storm to the point where detention is no longer helpful, and instead actually worsens flooding.

► **Recommendation:** Include language that encourages all applicants to go above and beyond the minimum standards established by these regulations to have a positive impact in flood prone areas. Where commercial applications are involved, require the applicant to provide a brief statement as to where the minimum standards are exceeded, and if they are not, why they couldn't be exceeded.

5 SAMPLE STORMWATER MANAGEMENT REGULATIONS

5.0 SAMPLE STORMWATER MANAGEMENT REGULATIONS

Any proposed zoning regulations must cover a number of areas:

1. Storm frequency for comparative hydrology and facility design;
2. The amount of development and/or activity that triggers the requirement for a stormwater review/plan;
3. Staff workload issues reviewing any submitted plans;
4. Staff enforcement issues;
5. Whether any properties should be exempt from stormwater quantity (but not necessarily quality) issues due to their specific location within a watershed.

5.1 ZONING REGULATION AMENDMENTS

A sample section of proposed zoning regulation amendments dealing with stormwater management is outlined below for consideration. Our recommendation would be that, given the importance of stormwater management and its applicability across all zones, it be a stand alone section within Section 800, where the environmental-related regulations are located. The regulations are presented below, in the left column, with a commentary on the right explaining the reasoning and intent behind each regulation.

<u>SECTION 880 – STORMWATER MANAGEMENT</u>

Stormwater management is the practice of controlling the discharge of stormwater from a site such that the quantity of flow does not exacerbate downstream flooding conditions, erosion conditions, or result in a cumulative adverse impact on properties proximate to, or downstream from the site, while managing and discharging the stormwater runoff in a manner that mitigates impacts to water quality.

The term "Stormwater Management" is preferred to "Drainage" because "stormwater management" implies that there are two critical facets which affect downstream flooding, specifically stormwater quantity <u>and</u> quality.

a. <u>Conformance to Established Standards.</u> Proposed stormwater management plans are to conform to the technical guidance and procedures outlined in the Darien Stormwater Management Manual.

b. <u>Applicability.</u> Applications for any site meeting one or more of the following criteria shall submit a stormwater management plan conforming with

Section 882:

1) construction or reconstruction of 1,000 square feet or more of impervious surface; or

The 1,000 square foot threshold is discussed in Section 4.12. of this document.

2) Submission of any application is subject to review and action by one or more of the local land use boards (Planning and Zoning Commission, Zoning Board of Appeals, Environmental Protection Commission); or

This would include all Filling and Regrading applications, all Site Plans for non-residential development, basketball and tennis courts, and other items which may not meet the criteria in (1) or (3). Each of the land use boards has the ability to hire an outside engineer to review the drainage at the applicant's expense.

3) Submission of an application for the demolition and reconstruction or replacement of an existing residential dwelling.

There were 51 total teardowns in 2007, and about half of those were reviewed and acted upon by a local land use board.

c. Impervious Surfaces. Impervious surface, for the purpose of this section is defined as new driveways and parking areas, structures, patios and equipment pads. Resurfacing of existing driveways, pools, and golf cart paths do not count as impervious surface.

The intent of narrowing the definition of imperviousness is to better manage workload, by regulating larger projects which have more of an impact, and not being overly burdensome to homeowners undertaking small projects. Please refer to Section 4.12

d. Emergency Situations. In order to help alleviate an emergency situation, a local land use board may waive the requirement for a drainage analysis in order to protect the health, safety, and welfare of the public. After the emergency situation ends, the action should be revisited after implementation as soon as practicable for conformance with the stormwater management regulations.

There may be situations that require the implementation of emergency flood control measures to protect the health, safety and welfare of the public. This section is designed to give flexibility in dealing with these situations. Please refer to the discussion in Section 4.13.

e. Exception for Coastal Areas. If a site is within the coastal area, and does not meet the criteria of subparagraph b(2) of this section, the requirement for a drainage analysis is waived, except for the drainage analysis normally required as part of the Coast Area.

This exception is in response to a Stormwater Subcommittee comment, since development in Coastal Areas does not contribute to downstream flooding because they are at the ultimate end of the watershed, and there is nothing downstream to flood. However, for sites subject to Coastal Area review, infiltration requirements would result in the need for a drainage analysis.

881. Basic Components of Stormwater Management Plans

All instances of comparative hydrology shall document no increase in downstream flooding conditions for the 2, 10, 25, 50 and 100 year storms or adverse cumulative impact on downstream property or property proximate to the site as a result of the proposed development.

Downstream analysis is necessary because flooding impacts can be worsened even if the total flow from the site is reduced.

a. Upstream and Downstream Drainage Basin Analysis. All proposed developments, which are likely to result in a discharge, or significantly increase the flow of an existing discharge into a storm drainage system or watercourse, must identify the upstream tributary drainage area and perform a downstream impact analysis. The downstream analysis shall be carried downstream to the point that the area of the site is 10% or less of the area of the watershed above, and include an assessment of potential cumulative adverse impacts arising from the discharge.

The "10 percent rule" is the generally accepted rule of thumb for downstream impact analysis, representing the point at which the watershed above is sufficiently large that the subject site's impact on the watershed is minimal. The upstream analysis is important in determining if there will be simultaneous peaking flows between the site and the watershed above, increasing peak flows in the receiving stream or system. This is especially critical where detention is proposed.

b. Nonstructural Drainage Systems. A stormwater management plan shall utilize non-structural approaches to controlling runoff to the maximum extent practicable, promoting the infiltration of rainfall into the soil and preservation of existing drainage patterns. Infiltration practices shall be placed such that they do not adversely affect nearby properties, structures, and or wetlands that may be proximate to the site.

Impervious surfaces prevent the infiltration of rainfall. In order to encourage infiltration, practices such as infiltration chambers, drywells and infiltration basins can be used to recharge groundwater. These practices may not be appropriate in all soils. The 2003 Darien Stormwater Management Manual provides specific infiltration requirements with respect to the Hydrologic Soil Group of the soil.

c. Wetland and Riparian Buffers. Natural vegetated and riparian buffers shall be preserved, restored, or established to the maximum extent practicable along watercourses and around wetlands.

Wetland and riparian buffers help renovate stormwater runoff flowing across them through vegetative uptake and infiltration. They also serve to slow velocities, preventing erosion and subsequent downstream deposition which could reduce channel conveyance capacity.

d. Stormwater Runoff Quality. All stormwater management plans shall include measures to prevent, to the extent practicable, discharge of pollutants from the site through the use of measures that control both the sources and prevent to the extent practicable, transport of pollutants. The pollutants shall be reduced such that 80 percent of the total mass of suspended solids are removed in comparison with the pre-treatment condition. This may be achieved through one or a combination of stormwater treatment practices, including, but not limited to, filter strips, sediment basins, groundwater recharge, extended detention basins, and gross particle separators. Where the goal of 80 percent cannot be achieved, the applicant shall submit an explanation detailing why this standard cannot be

Sediment transport poses a serious threat to both stormwater quality and downstream flooding conditions. As sediment is transported off the site, it will settle out of suspension in pipes and watercourses. Over time, the accumulation of sediment reduces the conveyance capacities of these conduits, and will lead to backups and channels overflowing their banks.

80 percent is the accepted goal established by the Connecticut DEP. The other 20 percent are generally clay particles which are small and remain in suspension indefinitely. The 2003 Darien Stormwater Management Manual provides specific guidance as to the documentation of TSS removal.

achieved.

e. Conveyance System. Conveyance systems for the proposed project must be analyzed, evaluated, designed, and constructed to accommodate existing upstream and off-site runoff onto a site in addition to the on-site runoff from the proposed development. The local land use board shall have the discretion to require that conveyance systems be properly sized to address potential adverse impacts.

Conveyance systems that cannot handle the design flows will back up, causing flooding at their inlets.

f. Outlet Locations. The runoff from proposed development sites should utilize existing outlets to the maximum extent practicable, unless it is demonstrated that using the existing outlet would exacerbate downstream flooding or result in adverse impacts to downstream properties or properties proximate to the site. Where new outlets are proposed, they shall be located at natural watercourses, wetlands, or man-made drainage systems with adequate capacity to handle the anticipated discharge.

The preference is to utilize existing outlets because they already have been established and do not require additional disturbance near wetlands and watercourses.

All point source outlets discharging from the property receiving runoff from the new development shall be stabilized with an energy dissipation method such as preformed scour holes or riprap aprons designed in accordance with the requirements of the Connecticut Department of Transportation Drainage Manual, as amended.

Energy dissipation reduces velocities, which in turn reduce downstream erosion and subsequent deposition further downstream that may reduce available stormwater conveyance in channels and watercourses.

Where level spreaders are proposed, calculations shall be submitted documenting that velocities do not exceed the erosive velocity of the existing soil type over the level spreader. The location of the point source is critical to avoid adverse impacts to property(ies) proximate to the site. Such point sources shall be located at a minimum of 10 feet inside the property line to allow for maintenance of the level spreader.

Level spreaders are designed to spread flow out across a broader area as opposed to a point discharge from a pipe. Level spreaders, because they widen the flow path ,and release water at slower velocities. However, they still must be maintained in order to be effective.

Where infiltration facilities are proposed, they shall be located a minimum of 10 feet from the property line.

This separation requirement is for maintenance.

g. <u>Maintenance and Operation</u>. Maintenance of all drainage facilities and systems constructed or modified as part of a proposed project, will be the responsibility of the property owner, unless otherwise dedicated to or the acknowledged responsibility of a government agency. Proposed Opeartion and Maintenance ("O&M") plans and schedules must be submitted with the application.

Submission of the Maintenance and Operation plans provides a basis for the Town to review the maintenance requirements for a project, if needed.

In general, the O&M plan for any such drainage facility or system shall provide for routine maintenance such as minor cleaning usually once or twice a year and insure that the drainage facility or system is unimpeded and operational. The O&M plan shall further provide that the drainage facility or system shall be inspected at least every two years by a professional engineer, with a copy of the inspection provided to the Planning and Zoning Commission. Inspections for sites and buildings with an even street number shall occur in even-numbered years, while inspections for those with an odd street number shall occur during odd-numbered years.

Inspections are important to verify that the stormwater management facilities are functioning as intended and to verify that they are being maintained properly. Providing copies of the inspection report allows the Town to quickly verify if inspections have been performed if the maintenance of a private system is questioned.

Upon approval by the Commission, the O&M plan shall be filed on the Land Records. Each O&M plan is to identify the specific drainage facilities or systems on the site, inspection methods and frequencies, and maintenance methods and frequencies.

Recording the plan on the Land Records ensures that the maintenance requirements are transferred in perpetuity.

h. <u>Licensed Professional Engineer</u>. All stormwater management plans, reports, calculations, and O&M plans and schedules shall be performed by, signed and sealed by a Professional Engineer licensed in the State of Connecticut.

A licensed Professional Engineer typically has the experience and knowledge necessary to design a stormwater management system with respect to the complex relationship of the upstream and downstream watersheds, not just the site itself.

i. <u>Exceedance of Minimum Standards</u>. Applicants are encouraged to exceed the minimum drainage standards set forth in these regulations to increase positive impacts in flood prone areas.

This section is in response to the Stormwater Subcommittee's endorsement of language encouraging property owners to go above and beyond the minimal standard where possible to have positive impacts in flood prone areas.

882. <u>Documentation Requirements</u>

Stormwater management plans and reports where required in these regulations, as defined in Section

880 shall include the following documentation:

a. Separate topographic contour mapping showing the existing and proposed drainage areas at an appropriate scale.

This allows the reviewer to see the on-site drainage patterns, for where the stormwater is ultimately draining to, and if any stormwater is contributed by off-site sources.

b. Floodplain boundaries and Stream Channel Encroachment Lines as defined by the National Flood Insurance Program and the Connecticut Department of Environmental Protection, respectively.

Filling of floodplains results in reduction of conveyance, which contributes to flooding conditions. Additionally, the Town is obligated to regulate development within a FEMA defined floodplain.

c. Inventory and evaluation of on-site hydraulic structures and watercourses, within or related to areas of proposed impact, including brooks, channels, culverts, bridges, dams, weirs, and dikes, with information on their flow capacity and physical condition. The limiting capacity of existing structures may, at the option of the Director of Public Works, be used to establish the allowable post-development peak flow rate from the site.

The capacity of these on-site hydraulic features is important to understand the impact of any effects where the structures do not have the capacity to pass the design flow. The option of the DPW Director to limit post-development peak flow rates to the capacity of existing structures guards against the possibility of these structures being overtopped.

d. Inventory and evaluation of on-site stormwater storage areas, including impoundments, riverine corridors, swamps, ponds, wetlands, floodplains, and miscellaneous depressions.

Significant natural storage areas can have a large impact on the timing relationship of discharges with respect to adjacent watersheds.

e. Identification of peak rate of runoff under pre-development and post-development conditions from the site at each design point. An evaluation of the potential impact of the peak runoff from the site upon properties proximate to the site and downstream locations such that the site represents 10% or less of the total watershed area.

Detention practices have a downstream zone of influence. Beyond this zone of influence, the structural control becomes relatively small and insignificant in comparison with the runoff from the total drainage area at that point. Based on studies and master planning results for a large number of sites, the limit of the zone of influence is considered to be the point where the drainage area controlled by the detention or storage facility comprises 10% of the total drainage area.

f. Specific documentation in support of stormwater management design shall include, but is not limited to the following:

The listed documentation is important to verify and establish consistency in the analyses as well as to understand basic assumptions that were used as parameters in the model.

(1) Method used to calculate stormwater runoff.

This is important to clearly identify the modeling method to assist the reviewer in determining if the selected method is appropriate for the situation.

(2) Runoff characteristics of the property before and after development.

This is needed to verify that existing and proposed conditions drainage patterns are similar and that the overall characteristics of the stormwater aren't negatively impacted.

(3) Watershed calculations used to develop NRCS Curve Number or Rational Method Calculations.

Typically, these calculations are used to evaluate the land use within a watershed area, and are often weighted to reflect varying land uses in a watershed. These are important to verify that appropriate land use coefficients and curve numbers have been used.

(4) Time of concentration calculations identifying length and slope of various components including overland, shallow concentrated and channel flow. Time of concentration paths to be shown on the watershed maps.

Time of concentration has a significant influence upon peak flow. Therefore, it is important to document the time of concentration path, and the land cover, slope, and other factors assumed in calculating the time of concentration for a watershed.

(5) Hydrologic model input and output files for all storms evaluated.

The input and output is important to verify that the calculations of the runoff coefficients, curve numbers and time of concentration are consistent with the watershed calculations.

(6) Subwatershed map delineating all contributing areas to each catch basin in a proposed storm sewer system.

Watershed areas should be delineated and documented to verify that all area contributing to a design point has been accounted for.

(7) Hydraulic computations for all storm drainage systems. Computations shall show hydraulic grade line elevations and structure rim elevations.

This is important to document that a proposed system has been designed with sufficient capacity and will not surcharge.

(8) Pond and storage area stage-storage-discharge calculations.

These storage area calculations are particularly important to verify that the storage volume used in the hydrologic model is consistent with the plans and calculated stage-storage-discharge relationship.

(9) Soils information, including depth to seasonally high groundwater and permeability testing and drawdown calculations for proposed infiltration systems, showing that the infiltration practice will drain within 24 hours.

Soil testing is critical to establish a design rate of infiltration, which will determine if the proposed infiltration practice will drain within 24 hours so that the full design volume is available for the next storm.

g. A complete set of construction plans. Where storm drains are proposed in roadways, the plans shall include storm sewer specifications and profiles.

Storm sewer profiles allow checking for conflicts with other crossing utilities.

h. Applicants for non-single family residential developments shall submit a brief statement evaluating if applying Section 881(i) is prudent and feasible.

Section 881(I) encourages property owners to go above and beyond the minimal standards where possible to have positive impacts in flood prone areas. Section 4.14 recommends a statement from commercial applicants, who are best positioned to have an impact because of the general size of their *developments.*

883. Hydrologic Evaluation

Various methods are available for hydrologic modeling, with some methods more appropriate than others. Most methods are based upon land cover and time of concentration relationships. Hydrologic models should use methods established by the Soil Conservation Service (now Natural Resources Conservation Service) or the United States Army Corps of Engineers. In all cases, the 2, 10, 25, 50 and 100 year storms shall be evaluated for existing and proposed conditions comparative hydrology, with the same modeling methodology used for both conditions. The Director of Public Works may waive the requirements herein if the applicant demonstrates, in writing, why a proposed alternate method of analysis is appropriate and adequate.

Some models may be more appropriate than others, depending on the site. The intent is to give the modeler some flexibility, define the storm events to be examined, and require the same methodology for existing and proposed conditions such that an "apples to apples" comparison can be made.

a. Basis of Existing Conditions Analysis Existing Conditions Analysis shall account for actual on-site conditions at the time of the proposal, accounting for all depressions, and types of land cover, except for applications involving the demolition of an existing residential dwelling or commercial building and replacement of the razed structure with a new structure.

Refer to Section 4.2 for a discussion of the basis of the existing conditions analysis. In general, it is best to use actual conditions, but using a more stringent basis of analysis for teardowns can provide some additional level of safety

Where an existing residential dwelling or commercial building is proposed to be razed and replaced with a new structure, the basis of existing conditions analysis shall be the site's undeveloped condition if there is no engineered detention system on the existing site. If there is an existing engineered detention system on the existing site, then the actual existing conditions at the time of application shall be used as the basis of the existing conditions analysis.

Detention systems on an existing site are often designed such that storm flows are over attenuated, and therefore, comparing a proposed development to existing conditions offers a more stringent basis of analysis than if the comparison were to an undeveloped condition. Please refer to the example in Section 4.2.

The local land use board may require a comparison to undeveloped conditions where warranted.

b. Detention Analysis A complete runoff hydrograph evaluation is required for projects utilizing detention methods. Hydrograph evaluations shall be conducted for pre-development and post-development

Hydrographs establish the timing relationship between the inflow into the pond and the outflow from the pond.

conditions for storms with return frequencies of 2, 10, 25, 50 and 100 years.

c. Time of Concentration Times of concentration used in all hydrology models shall be based upon the method outlined in the Connecticut Department of Transportation Drainage Manual, most recent version and addenda thereto.

Times of concentration are critical in determining timing relationships, which directly affect flooding. Calling out a specific methodology will allow for consistency in determination.

d. Design Frequencies

Design frequencies should vary depending upon the function of the facility, and the facilities impact upon existing structures and properties. Refer to the discussion in Section 4.3.

Facility	**Design Frequency**
Storm Drains	
Local Streets	25
Parking Lots	25
Collectors and Arterial Streets	25
Collector and Arterial Streets at Sags[1]	50
Drainage Channels and Ditches	25
Culverts[2]	
Upstream watershed area < 1 square mile	50
Upstream watershed area ≥ 1 square mile	100
Bridges	100
Detention Facilities	100

[1] Sags are defined as the lowest point in a vertical curve where water can only be removed through a storm system. The inlet at the sag shall be designed to accommodate a 50-year storm, while the remainder of the storm drainage system can be designed to accommodate the 25-year storm.

[2] Crossings of watercourses will require design for the 100-year storm, regardless of the size of the upstream watershed area. For those critical activities as defined in Section 25-68b through 25-68h, CGS, the design storm frequency shall be 500 years.

884. Peak Flow Attenuation

a. The discharge of stormwater runoff from development sites shall not cause adverse impacts to properties proximate to the site or cause adverse impacts downstream from the site. In all cases, the applicant shall perform a watershed study to document that the proposed development will not cause or exacerbate flooding on properties proximate to, or downstream from the site. The limit of this study will be the downstream point at

Detention practices have a downstream zone of influence. Beyond this zone of influence, the structural control becomes relatively small and insignificant in comparison with the runoff from the total drainage area at that point. Based on studies and master planning results for a large number of sites, the limit of the zone of influence is considered to be the point where the drainage area controlled by the detention or storage facility comprises 10% of the total drainage area.

which the site represents 10% or less of the total watershed area. This study shall be done for the 2, 10, 25, 50 and 100 year storms.

885. Infiltration and Stormwater Quality

Infiltration shall be utilized where appropriate to reduce stormwater runoff rate and volume, to improve stormwater quality, and to recharge groundwater. Runoff from areas with high pollutant loadings, such as gasoline stations shall not be infiltrated.

Infiltration helps attenuate peak flow rates, volumes, treats stormwater pollutants, and promotes recharge of groundwater.

All infiltration practices shall be subject to pretreatment with another stormwater best management practice.

The following runoff depths over the site impervious area shall be infiltrated where appropriate and feasible, unless waived by the Director of Public Works:

Hydrologic Group	Depth, Inches
A	0.40
B	0.25
C	0.10
D	No recharge requirement

The following measures shall be applied on the development site to the maximum extent practicable:

a. Roof Runoff. Roof runoff from non-metal roofs shall be directed into infiltration systems or onto stable vegetated soils for at least 50 feet where practicable to encourage infiltration and groundwater recharge. Excess roof runoff may be directed overland or to watercourses or storm drains by grass swales or perforated pipes.

Rooftop runoff is generally considered to be cleaner and best suited for infiltration, because it is not subject to the same level of accumulation of pollutants as ground-level impervious surfaces.

b. Pavement Runoff. Pavement of parking lots, driveways and similar areas shall be designed to encourage groundwater recharge via the use of infiltrative systems. Parking lots with heavy usage or near water

In addition to chambers, other methods to encourage infiltration, parking lot islands can be curbless and depressed to encourage water to collect and infiltrate.

supply sources shall include measures to eliminate to the extent practicable, and/or reduce the potential for groundwater contamination, including oil traps, sediment basins, vegetated filters, etc. prior to infiltration systems. The use of grass median strips and depressed islands are encouraged.

c. Driveway Runoff. Where appropriate, residential driveways shall be graded to encourage sheet flow, non-point runoff flow onto pervious areas such as grass lawns and woodlands rather than directly to catch basins or drainage systems.

Directing sheet flow across vegetated areas slows velocities, lengthens flow paths and encourages infiltration. This also cools the driveway runoff before discharge to a wetland or watercourse.

d. Sheet Flow. Runoff shall be designed into sheet flow across natural or artificially vegetated areas where appropriate.

Directing sheet flow across vegetated areas slows velocities, lengthens flow paths and encourages infiltration.

e. Total Suspended Solids. Applicants shall submit calculations documenting the anticipated removal percentage of post-treatment total suspended solids with respect to the post-development conditions without stormwater treatment.

The Connecticut DEP has established a goal of 80% removal target for Total Suspended Solids, which is the primary pollutant benchmark for quality.

886. Stormwater Detention Facilities

Detention facilities are useful in controlling the peak rate of runoff, but require engineering analysis to verify that they are adequately designed and do not exacerbate downstream flooding conditions.

Stormwater detention facilities to temporarily store excess runoff may be used to control peak flow rate and duration of downstream flows when coordinated with the runoff characteristics of the watershed in which they are located and the local site conditions.

a. Any detention system, the failure of which may present a risk of significant damage or risk to life may be regulated as a dam by DEP pursuant to Sections 22a-401 through 22a-409 of the General Statutes. The Town Public Works Director shall be copied on all correspondence.

The DEP does not have specific sizing or height criteria that triggers a review, and instead looks at downstream impacts in the event of a breach.

b. The stormwater released from a detention facility shall not cause, contribute to or exacerbate downstream flooding conditions.

Detention can worsen downstream flooding conditions if the peak from the detention pond coincides with the peak of the watershed the pond discharges into.

c. Detention ponds shall have a minimum freeboard of one foot for the 100-year storm.

Freeboard provides a margin of safety to prevent overtopping which can significantly degrade the embankment of the pond.

d. An O&M plan shall be prepared for every detention facility, identifying responsibilities and items of routine maintenance, and emergency operations in the event of a flood.	*Maintenance is critical to ensuring that detention facilities function as designed.*
e. Detention basins shall have an emergency discharge outlet with a capacity equal to the discharge from a 100-year frequency flood, with routing computations.	*Emergency outlets provide a final stabilized outlet path in the event the outlet works become clogged, avoid overtopping.*
f. Where proposed, the design of a detention pond shall be supported by the following information:	*The listed documentation is important to verify and establish consistency in the analyses as well as to understand basic assumptions that were used as parameters in the model.*
(1) Plan with a scale of not less than 1" = 40' showing proposed contours with a maximum 2-foot interval.	*Contours are important to verify the storage available inside a detention pond.*
(2) Details of the outlet.	*Outlet details are necessary to verify consistency with the discharge calculations for the detention pond.*
(3) Inflow hydrograph with outflow hydrograph superimposed upon it.	*This allows the reviewer to see the impact the detention pond has upon the time of concentration.*
(4) Cross sections of embankment and spillway.	*The cross sections are important to understand the types and depth of material that will make up the embankments and spillways.*
(5) Elevation-storage curve or table.	*The elevation-storage curve or table allows the reviewer to verify data used in the calculations is applied properly.*
(6) Elevation – discharge curve or table.	*The elevation-discharge curve or table allows the reviewer to verify that the data used in the calculations in applied properly.*
(7) Flood routing calculations.	*These calculations are necessary to verify that the detention pond is sized properly and will not overtop the pond.*
(8) Evaluation of the subsurface conditions relative to water table, ledge and soil permeability.	*Water table shall be verified to determine if any of the prescribed storage volume will be taken up by groundwater. Ledge and soil permeability are also important to verify that there will be no negative downstream impacts from a geotechnical perspective.*
(9) Materials to be used for construction.	*Materials proposed to be used in the construction of the detention pond should be reviewed for their appropriateness for the site and proposed use.*

(10) Methods employed to avoid outlet opening clogging.

If an outlet is clogged, the water level inside the pnd can rise rapidly and cause the pond to be overtopped.

(11) Proposed landscaping and vegetative measures used to stabilize slopes and bottom surfaces.

Detention pond slopes must be vegetated to be stabilized, and offer an opportunity to plant aquatic-type plants.

(12) Interior slopes shall not exceed a ratio of 3 horizontal to 1 vertical..

Steep slopes inside the pond present maintenance difficulties and safety concerns. 3:1 is what is recommended in the Connecticut Stormwater Quality Manual..

887. Stormwater Conveyance Systems

a. Natural systems, including perennial and intermittent streams, swales and drainage ditches, shall be maintained in an open condition to the maximum extent practicable.

Leaving existing natural systems open makes accessibility for maintenance much easier, and also makes it much easier to observe a potential problem because it is not hidden.

b. Conveyance systems shall be designed to minimize changes in the runoff travel time through the use of overland flow, grass lined channels and surface depression storage.

Changing of timing relationships should be avoided where possible because of the potential negative impact it could have on downstream flooding conditions.

c. Closed storm drainage systems involving storm drain pipes shall be designed to:

(1) Have a minimum capacity for the 25-year frequency storm flow.

Larger storm events are limited by the interception capacity of catch basins and other inlets into the system.

(2) Utilize the appropriate Manning's roughness coefficient as prescribed by the Town Stormwater Management Manual as revised.

The conveyance of the pie is impacted by its slope, but also by the material of construction. Plastic pipes have better hydraulic capacity than reinforced concrete pipes, which have better capacity than corrugated metal pipes.

(3) Have a minimum of 2 feet of cover or adequate cover and strength to support AASHTO HS-20 loading.

Minimum cover helps guard against pipe deflections due to loading. Pipe deflections reduce the capacity of pipes, and in extreme circumstances can cause collapse and complete failure.

(4) Keep the hydraulic grade line a minimum of one foot below the rim or grate elevation of the structure.

Although a pipe may have flow capacity, junction losses can cause the hydraulic grade lines to rise above the crown of the pipe, resulting in pressure flow.

d. All storm drainage systems shall be designed and constructed to accommodate runoff from upstream contributing areas without causing an adverse impact on properties proximate to or downstream from the system.

Storm drainage systems can back up if they are not sized for the full contributing area.

887A Culverts and Bridges

a. The hydraulic analysis and design of culverts

Freeboard provides a factor of safety against shall consider the orifice flow conditions at the inlet, the capacity of the pipe itself, and the depth of water at the outlet (tailwater). All flow conditions have to be analyzed to determine which condition is the most restrictive. Culverts and bridge openings shall be designed to provide a minimum freeboard of 1 foot as measured from the top of the design water surface elevation or top of culvert, whichever is greater, to the top of the embankment supporting the roadway.

overtopping.

b. 100-Year water surface elevations shall not be increased by more than one foot, or 0.1 feet on the Noroton River, nor allowed to cause damage or increased flooding to upstream properties.

The National Flood Insurance Program does not allow increases in excess of 1 foot for 100-year water surface elevations. The City of Stamford has adopted a stricter standard, 0.1 foot. Since Darien shares a border with Stamford on the Noroton River, the 0.1 foot threshold must be adhered to.

c. Suitable headwalls or flared-end sections shall be provided at the open end of any pipe; wing type headwalls shall be provided at the open end of large pipe. Culverts under streets may be extended to the edge of the right-of-way of the street.

Headwalls provide a defined edge, can serve to channel flow into a structure, and also provide stability for the end of the culvert.

d. The location of new culverts or bridges shall minimize the relocation of watercourses.

Maintaining existing channel banks is usually easier than creating and trying to stabilize new ones.

e. Enclosing streams in culverts, other than road or driveway crossings, should be avoided so that natural stream corridors are maintained.

Leaving streams open preserves the natural state and also makes maintenance access easier.

887B. <u>Catch Basins</u>

a. Catch basin spacing and type shall be determined by gutter flow design, and the need for future lot drainage. A drainage structure shall be placed at each grade change, horizontal direction change, and at the junction of two or more drains.

This is to minimize the amount of flow that bypasses catch basins during heavier rainfall events.

b. All catch basins within intersectional areas are to be located five (5) feet before all Points of Curvature (P.C.'s) and Points of Tangent (P.T.'s) along the curb alignment.

More catch basins are required at intersections to keep water from flowing across the road.

c. A complete "Gutter Flow Analysis" will be performed to determine catch basin spacing

Where half of each lane is submerged, this still provides a width in the middle to allow for emergency vehicle access.

and type in roadway sags. Flooding shall not exceed one half of the lane width. The design procedures for gutter flow analysis outlined in the State of Connecticut Department of Transportation "Drainage Manual" latest edition shall be followed unless another method is approved by the Director of Public Works.

d. All catch basins shall have a sump to trap sediment. The sump shall be a minimum of 24-inches deep below the lowest pipe invert. Catch basin sumps must be watertight.

Sumps catch heavier debris, preventing it from travelling downstream. Sumps should generally not be allowed to infiltrate because of the oils washed in from roadway surfaces.

e. Catch basins subject to potentially high debris loads of floatable material shall be equipped with a hood or baffle to prevent discharge of floating material

Catch basin hoods prevent transport of debris into the pipes and downstream elements of the system.

887C <u>Open Channels</u>

Land clearing and grading within a wetland or natural stream corridor should be avoided or minimized, except at stream crossings, so that streams remain in a natural state. Even where work is minimized, it may be subject to local, state and federal permitting requirements

Care should be exercised to avoid, or minimize disturbance of riparian vegetation, including grasses, shrubs and trees in the stream corridor, wetland, or along the watercourse.

Vegetation helps stabilize channel banks and promotes uptake of pollutants from overland flow.

a. Type A open channels are classified as local drainage channels with a primary purpose of conveying urban, parking lot and road runoff from small watersheds, frequently with intermittent flow and limited ecological value and are intended to convey their design flow within their banks. They shall be designed in accordance with the following:

(1) Freeboard allowances from the top of the design storm water surface elevation to the top of the channel of at least one foot shall be provided.

Freeboard provides a factor of safety against overtopping.

(2) The use of impervious linings is discouraged, for situations where velocities warrant some form of

Vegetative linings are best suited for pollutant removal.

protective lining, permanent turf reinforcement mats are encouraged.

(3) Channel linings or vegetative measures shall be designed to protect channel perimeter for the peak flow of the design storm. Calculations shall be submitted in the storm water management report.

Stabilization of channel slopes prevents the banks from scour and erosion.

b. Type B open channels are classified as natural perennial watercourses or man-made channels planned to simulate a natural watercourse. They shall be designed in accordance with the following where appropriate:

(1) Shall have a minimum flow capacity of a flood equal to at least 25 -year frequency flood;

Since the storm drainage systems discharging to them shall be designed for the 25-year storm, these, as receiving channels, should also have the same design frequency.

(2) Shall have water surface profiles prepared for the 2, 10, 25, 50 and 100- year frequency floods;

This is important to determine what is impacted if the channel does overtop. If structures are impacted, then the design frequency shall be increased.

(3) Shall be designed to minimize the need for artificial linings (concrete, rip rap, asphalt, etc.)

Vegetative linings provide the best opportunity for pollutant removal.

(4) Shall encourage ecological productivity and variety;

This should be a goal if these channels are to replicate natural conditions.

(5) Shall be visually compatible with its surroundings;

Visual continuity is important to creating a natural appearance.

(6) The alignment and slope shall be compatible with natural channels in similar site conditions;

The intent is to keep the channel geometry in accordance with natural conditions.

(7) Variations in width, depth, invert elevations, and side slopes are encouraged for aquatic and visual diversity;

Straight, geometrically regular channels do not have a natural appearance and have reduced renovation functions.

(8) Straightening channels and decreasing their length is discouraged;

Straightening reduces flow path length, increases velocities, and reduces pollutant uptake because of the shorter flow path.

(9) The cross sections used to determine the channel and floodplain geometry

Cross sections should be descriptive of the changes in the channel, and are especially for water surface profile computations shall be located upstream and downstream of hydraulic structures, at changes in bed slope or cross-section shape, and generally at intervals of not more than ten times the width of the 100-year floodplain; and

critical at hydraulic structures, such as bridges.

888. Certification and Maintenance Agreements

a. Prior to obtaining final Planning and Zoning signoff on a project, a O&M plan shall be recorded on the Darien Land Records. The O&M plan shall stipulate the inspection frequency, maintenance requirements and intervals for all proposed stormwater management practices on the site.

Recording the requirements on the land records allows subsequent property owners to understand the maintenance requirements associated with the on-site stormwater treatment practices, and identifies the requirements in perpetuity.

b. Prior to obtaining final Planning and Zoning signoff on a project, a Connecticut licensed surveyor shall prepare and submit an improvement location survey, depicting pipe inverts, diameters and sizes, as well as structure inverts and elevations and other information to adequate describe the constructed stormwater management system. The survey shall also indicate the extent of impervious surfaces; and topography of the completed site where changes in grade exceed one foot.

This provides a record of what has been installed on the site.

c. Prior to obtaining final Certificate of Occupancy on a project, a professional engineer shall certify that the proposed drainage system was installed in conformance with the approved plans.

This certification provides a check that the installed system is reasonably close to what had been depicted on the plans.

5.2 SUBDIVISION REGULATION AMENDMENTS

The Subdivision Regulations should be amended by the Planning and Zoning Commission to make specific reference for any subdivision to comply with Section 880 of the Darien Zoning Regulations.

5.3 INLAND WETLAND AND WATERCOURSES REGULATION AMENDMENTS

The Inland Wetland and Watercourses Regulations should be amended by the Environmental Protection Commission to make specific reference for any application to comply with Section 880 of the Darien Zoning Regulations

A THRESHOLD APPLICATION EXAMPLES

Section 4.12 of this report discusses the thresholds at which a drainage analysis is required. Specifically, a drainage analysis will be required for projects involving:

1. Construction or reconstruction of 1,000 square feet or more of impervious surface; or

2. Submission of any application is subject to review and action by one or more of the local land use boards (Planning and Zoning Commission, Zoning Board of Appeals, Environmental Protection Commission); or

3. Submission of an application for the demolition and reconstruction or replacement of an existing residential dwelling.

Table A.1 below illustrates examples of how the thresholds apply or do not apply to a given circumstance.

TABLE A.1. Impervious Surface Threshold Application Examples

Application Examples
1. A homeowner proposes adding a 20 foot by 20 foot patio. Is a drainage analysis required? No. The patio is only 400 square feet, which is less than the 1,000 square foot threshold.
2. A property owner proposes to raze an existing 3,000 square foot one-story ranch house and build a new two-story colonial with a 2,700 square foot first floor footprint. Is a drainage analysis required? Yes. Although the first floor footprint will be reduced by 300 square feet in comparison with the existing structure, since the proposal involves tearing down an existing residential dwelling and replacing it with a new one, a drainage analysis is required.
3. An applicant is proposing modification of the circulation pattern in an existing parking lot that would involve adding new landscaped islands and an additional 750 square feet of impervious surface for additional parking. This project requires a Site Plan review and action by the Planning and Zoning Commission. Is a drainage analysis required? Yes. Although the 750 square feet of additional impervious area is less than the 1,000 square foot threshold, since the project is subject to review and action by a local land use board, a drainage analysis is required.

4. A homeowner is reconfiguring their driveway, such that the existing 1,500 square foot driveway will be removed, and a new 1,800 square foot driveway built on a new alignment.

No. The homeowner is adding just 300 square feet of additional impervious surface in comparison with existing conditions.

5. A property owner proposes to raze an existing 3,000 square foot one-story ranch house and build a new two-story colonial with a 2,700 square foot first floor footprint. Is a drainage analysis required?

Yes. Although the first floor footprint will be reduced by 300 square feet in comparison with the existing structure, since the proposal involves tearing down an existing residential dwelling and replacing it with a new one, a drainage analysis is required.

6. A property owner proposes to pave their 1,200 square foot gravel driveway. Is a drainage analysis required?

No. Gravel driveways would already be considered impervious under these regulations.

7. A property owner proposes to repave their 1,800 square foot driveway, and add a paved 1,000 square foot parking/turnaround area in the lawn near their garage. Is a drainage analysis required?

Yes. Although repaving an existing driveway does not add additional impervious surface, the addition of a 1,000 square foot parking/turnaround area does add additional impervious surface, triggering the 1,000 square foot threshold for drainage analysis.

8. A homeowner proposes to raze an existing 225 square foot shed and replace it with a 256 square foot shed. Is a drainage analysis required?

No. Although this is essentially a “teardown” of an existing shed, the automatic drainage analysis requirement for teardowns only applied to residential dwellings. Sheds are not residential dwellings.